Journal of Animal & Plant Sciences, 33(6): 2023, Page: 1490-1496
ISSN (print): 1018-7081; ISSN (online): 2309-8694
https://doi.org/10.36899/JAPS.2023.6.0688

ROOT REGENERATION OF OLIVE (*OLEA EUROPAEA* L.) CUTTINGS: EFFECTS OF MEDIA INJECTIONS AND DELAYED APPLICATIONS OF AUXINS

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ABSTRACT

The rooting ability of'Domat'olive cuttings is very low.Therefore, it is necessarily propagated by grafting onto seedling rootstocks. Hence, nursery tree propagation is time consuming and costly. Thus, this work was necessitated to predict the effects of auxin injections to the rooting medium to support the exogenously applied auxin. Besides, predicting the auxin sensitive phase of rooting, when the applied auxin showed the highest efficiency on cuttings treated with hormones, in different days from the cutting insertion was also aimed. Semi-hardwood olive cuttings was used. As the rooting medium,phenol-formaldehyde foam and paper pot were used.The highest rooting percentage (76.6%) was obtained from the foam,injected with 50 mg l^{-1}IBA. However, the highest root number (2.9) and root length (54.1 mm) were observed in foam medium, without injected with IBA. As for the delayed application of hormones, cuttings treated with 5000 mg l^{-1} IBA on day 5, gave the highest figures of percent rooting (83.3%) and the other rooting parameters. Application of 5000 mg l^{-1} IBA 5 days later than cutting insertion, would be a good approach due to the highest rooting, and root quality of the cuttings of the studied cultivar and some other table olives which have difficult-to-root cuttings as well..

Keywords: IBA, NAA,*Olea europaea* L., root formation, rooting plug.

Published first online September 01, 2023 Published final December 13, 2023

INTRODUCTION

One of the most ancient cultivated fruit species of Mediterranean basin is probably the olive (*Olea europaea* L.). Olive tree started to be grown worldwide since the second half of the 20th century (Therios, 2009)due to the increasing demand for olive oil (Iqbal *et al*., 2020). Propagation of olive tree has been conducted asexually by using the large parts (e.g. branches, ovules, suckers) in practice through history,but propagation by semi-hardwood cuttings under mist chamber, has been accepted as a common practice since the mid-1950s (Fabbri *et al.,* 2004). However, almost all olive countries have at least one or more cultivars known to be hard to root, so they have necessarily been propagated by budding/grafting onto the seedlings or clonal rootstocks (Caballero and Del Rio, 2010).

'Domat'is known to be the predominant large fruiting (140 fruit kg^{-1}) table olive cultivar of Turkey. It is distributed unevenly throughout the Aegean region (West Anatolia), with Akhisar at the center of growing area where the Mediterrenean climatic conditions are prevailing. Owing to it's high and constant productivity and early bearing, it is very suitable for intensive irrigated orchards. 'Domat' olive has a very large canopy. Cumulative yield was measured as 22 kg $tree^{-1}$ from 5 to 8^{th} years, under irrigated conditions, in 6x6 m planting distance (Toplu *et al.,* 2009). But in traditional orchards, fruit yield per tree that can reach up to 200 kg or sometimes more is common.It's a self fertile variety and also used as a pollinizer. It is particularly suitable for green consumption or processed as a snack by various kinds of stuffings (Barranco *et al.,* 2000). Despite it's relatively low oil yield (≤18%), extra virgin oil of 'Domat' olive has an increasing demand in niche markets in currency, because of its different phenolic profile (Ocakoğlu *et al.* 2009) and sensory characteristics. Leafy semi-hardwood cuttings of 'Domat' olive are very recalcitrant to root in practice. So, nursery tree production has been done by grafting onto the seedling rootstocks. Former works aimed on to predict the effects of exogenous auxins and their combinations, polyamines, phenolics, besides the cutting collection time, cutting length, girdling, wounding and rooting medium on the in vivo rooting of 'Domat' cuttings showed that, rooting percentage did not exceed 68% (Seyhan Usta, 1999; Gerakakis and Özkaya, 2005; İsfendiyaroğlu and Özeker, 2012; İsfendiyaroğlu, 2016). Exogenous indole butyric acid (IBA) applications are necessary for rooting of olive cuttings, but recalcitrant to root cultivars do not respond well to IBA even at the very high concentrations (Fabbri *et al.,* 2004). In some plant species, naphthalene acetic acid (NAA) was more effective than IBA in stimulating the adventitious roots in cuttings (Fabbri *et al.,* 2004), with a few exceptions in olive (Porfirio*et al.* 2016a). The effects of NAA in olive cuttings seem to depend on the cultivar, concentration used and formulation as well (İsfendiyaroğlu, 2016; Al Hattab *et al.* 2018). In mature 'Domat' olive cuttings, the mixture of 5:2 g l^{-1} (IBA:NAA) resulted in the highest rooting percentages (40 and 60% respectively) and root quality in two consecutive years (İsfendiyaroğlu, 2016). It was proved that adventitious root formation comprised three successive, interdependent phases (e.g., induction, initiation and expression) (Gaspar*et al.* 1997). Moreover, De Klerk *et al*. (1995), pointed out a dedifferentiation phase before root induction, during which the exogenously applied auxin was ineffective. So, the highest sensitivity to auxin application occurred after a later time from cutting collection was reported (De Klerk*et al.* 1999). As a matter of fact, initial auxin pulses even at supra-optimal concentrations may not coincide with the auxin sensitive or induction phase of rooting, and less effective in difficult to root olives. Rugini *et al*. (1991), pointed out the significant changes in contents of some polyamines involving with root induction, occurred at 3-7th days of in vivo rooting of 'Frangivento' olive cuttings.

In 'Domat' olive cuttings from vigorous shoots (partially juvenile) delayed (5th day) application of IBA (5 g l^{-1}) gave rise to a significant increase (35%) in percent rooting, compared to cuttings that initially treated with IBA. Moreover, entire rooting parameters dramatically decreased in parallel with the treatments at 10 and 15th days (İsfendiyaroğlu2016). In olive cuttings, exogenously applied IBA, which is also a natural auxin (Epstein andLudwig-Müller, 1993)was metabolized to indole acetic acid (IAA), and IBA remained at the base of cutting, and released free IAA which would be needed for the root regeneration. However, the conversion of IBA into IAA was faster in hard-to-root cuttings than easy-to-root ones (Epstein and Lavee1984). Rooting ability depends on the formation of IAA from IBA, and a certain ratio of both auxins must be maintained. So the free hormone level at the base of cuttings, during a critical phase of rooting, is crucial (Epstein andLudwig-Müller1993,De Klerk*et al.* 1999). From this point of view, media injections at low concentrations of slow releasing forms of auxins, might be useful in difficult to root cuttings, by supporting to exogenously applied IBA. In fact, IBA injections at low concentrations (10-50 mg l^{-1}), in pre-sized rooting plugs, significantly increased the rooting of very difficult-to-root hardwood 'Ramsey' vine rootstock cuttings (Kacar and İsfendiyaroğlu 2019).

In this work, the main objectives were todetermine the effects of different auxin injections at different concentrations into the rooting medium, for supporting the exogenously applied auxins to 'Domat' olive cuttings and topredict the auxin sensitive phase of cuttings by the delayed exogenous auxin applications. Obtained results might also be useful to optimize the adventitious rooting in some commercially important olive cultivar cuttings, which are recalcitrant-to-root.

MATERIALS AND METHODS

Semi-hardwood olive cuttings were collected in mid-April 2020,from selected, bearing mother trees under the good care conditions in the research and production area of Ege University, Faculty of Agriculture, Department of Horticulture, İzmir/Turkey (38°27'25.09"N; 27°13'20.59"E; 31 m asl). One-year-old shoots from the outer canopy were used as cutting source. Subterminal cuttings of 12-15 cm in length with 2-3 pairs of leaves were used. The thickness of cuttings (3-4 mm) was homogenized through use of a shoot calliper. Cuttings were soaked in fungicide solution (0.1 % prochlorase) before quick dipping for 5 sec in solutions of 5000 mg l^{-1}IBA and 2000 mg l^{-1}NAA (Merck, for biochemistry ≥99.0). Acidic forms of both auxins was dissolved in 50% isopropanol (propane-2-ol). Control cuttings were only dipped in 50% isopropanol solution. Cuttings were rooted in pre-sized paper pots (Van Der Knaap-Antalya Substrat/Turkey) that contained 45% coir+ 45% peat + 10% fine perlite, pH:6.0 and phenol formaldehyde foam (Oasis) (17 kg m^{-3}-pH:6.2). Rooting plugs of 2.5 cm in diameter and 5 cm in length were placed in plug trays. To support the exogenous auxins, six different IBA concentrations (0, 10, 20, 30, 40, 50 mg l^{-1} respectively) were injected into the rooting plugs at the day before planting by using automatic pipette. Before the injections, rooting plugs were carefully drilled 2.5 cm in depth by hand, through use of a drill bit 3 mm in diameter. Injection solutions were prepared by dissolving the necessary amounts of auxins in 5 mL isopropyl alcohol and made up to volume with pure water. Thirty ml of these solutions was injected to each rooting plug, and they were kept at the room temperature to allow the complete evaporation of alcohol. Then, all the rooting plugs were saturated with the constant volume of water for 24 h before planting. To predict the auxin sensitive phase of rooting, untreated cuttings were planted in foam plugs and pulled out on the 5, 10 and 15th days respectively after the experiment initiation, for exogenous auxin applications. The basal portion of cuttings slightly washed, and excessive water was taken with a paper towel. Basal cuts of cuttings were renewed by cutting the 1-2 mm proximal ends of cuttings just under the bottom node, and they were immediately soaked with 5000 mg l^{-1}IBA and 2000 mg l^{-1}NAA, for 5 sec before replanting (İsfendiyaroğlu, 2016). Cuttings were rooted in a high polyethylene tunnel equipped with mist nozzles, located in a shaded greenhouse. Cycles of misting were controlled by an electronic leaf during the daylight hours (1 h from dawn to 1 h before dusk in bright days). Bottom heat was adjusted to 30°C at the beginning, and gradually decreased to 25°C at the end of the experiment. The greenhouse has also side and roof ventilation and equipped with a high-pressure fogging system. Cuttings were examined eight weeks after planting to determine the root and cutting quality parameters. The measurements were done with a millimetric ruler. The fresh callus volume was measured by separating the cortex tissue of 2 cm from the proximal end of cutting from wood and placing in pure water. The volume of excess water was measured and callus volume calculated. A completely randomized, simple factorial design with three replications (10 cuttings per each) was used where rooting media, auxin, additional IBA concentration, initial auxin and delayed auxin application were the experimental factors of the study. The data were subjected to analysis of variance by JMP (version 8.0, USA) software, and differences between means were determined by Fischer's Least Significance Difference (LSD) test. The correlations between number of roots and fresh callus volume were determined by using Pearson's Correlation test. The rooting percentage was calculated by getting percentage of rooted cuttings of tree replicates. And the data were subjected to statistical analysis following arcsin transformation.

RESULTS AND DISCUSSION

Media injections: In olive cuttings, effects of different auxins and *mediumx auxin* interactions were significantly affected ($p \leq 0.01$ and $p \leq 0.01$ respectively) the percent rooting. IBA gave the markedly high rooting percentages in both media. Interactions of *pot x concentration* and *foam x concentration* were found to be non-significant in terms of most rooting variables, except for fresh callus volume. Despite the non-significant interaction found between *media x auxin x concentration*, IBA injection at 50 mg l^{-1}gave the highest percentage of rooting (76.6%) followed by 0 and 10 mg l^{-1}in foam plugs. Also, IBA injection of 50 mg l^{-1}resulted in more than 60% increase in percent rooting of cuttings in pot plugs, compared to non injected ones. Markedly lower figures were observed in NAA injections in both media (Table 1).

Table 1. Effects of different media, auxin and concentration on rooting percentage (%) of cuttings.

Medium	Auxin	Injection Concentration (mg l^{-1}) 0	10	20	30	40	50	Medium x Auxin
Pot	**IBA**	36.67 ^{w}(21.54)^{ns}	46.67 (27.82)	50.00 (30.00)	40.00 (23.59)	40.00 (23.59)	60.00 (36.87)	45.56 (27.24)B**
Pot	**NAA**	13.33 (7.67)	6.67 (3.82)	36.67 (21.51)	16.67 (9.59)	26.67 (15.47)	13.33 (7.66)	18.89 (10.95)C
Foam	**IBA**	66.67 (41.81)	66.67 (41.81)	40.00 (23.58)	53.33 (32.23)	60.00 (36.87)	76.67 (50.06)	60.56 (37.73)A
Foam	**NAA**	3.33 (1.91)	16.67 (9.59)	3.33 (1.91)	10.00 (5.74)	3.33 (1.91)	10.00 (5.74)	7.78 (4.47)D
IBA x Conc.		51.67 (31.67)	56.67 (34.82)	45.00 (26.79)	46.67 (27.91)	50.00 (30.23)	68.33 (43.47)	
NAA x Conc.		8.33 (4.79)	11.67 (6.71)	20.00 (11.71)	13.33 (7.67)	15.00 (8.69)	11.67 (6.70)	
Conc. mean		30.00 (18.23)	34.17 (20.76)	32.50 (19.25)	30.00 (17.79)	32.50 (19.46)	40.00 (25.08)	
Medium mean								
Pot	32.22 (19.09)				**Foam**	34.17 (21.1)		
Auxin mean								
IBA	53.06 (32.48)A**				**NAA**	13.33 (7.71)B		

^{W}: transformed value. *Auxin* LSD: 5.52, *Medium x Auxin* LSD: 7.78
Means followed by different letters are significantly different according to the LSD test.*=P≤0.05; **=P≤0.01; ns= non-significant.

Mean number of roots per cutting was significantly ($p \leq 0.01$) higher with IBA treatment compared to NAA. *Medium x auxin* interaction also significantly ($p \leq 0.05$) affected the root number figures, and cuttings produced the highest number of roots with IBA treatments in foam and pot media respectively (Table 2). Interaction of *media x auxin x concentration* found to be non-significant. The highest number of roots (2.9) obtained from IBA treated cuttings in foam, without auxin injection.

Different auxins significantly ($p \leq 0.01$) affected the length of roots produced. IBA gave the longest roots compared to NAA. Significant ($p \leq 0.01$) interaction also found between *medium x auxin*, and the longest roots were obtained from foam plugs with IBA injections (Table 2). Interaction of *media x auxin x concentration* did not significantly affect the root length figures. The highest mean length of roots (54.0 mm) obtained from IBA treated cuttings rooted in foam, without auxin injection.

Table 2. Effects of different media and auxins on the rooting parameters of cuttings.

Medium	Auxin	Root Number	Root Length (mm)	Root Fresh Weight (mg)	Root Dry Weight (mg)	Shoot Length (cm)	Leaf Number
Pot	**IBA**	1.68B*	27.20B**	40.47B*	3.46B**	3.86^{ns}	0.72^{ns}
Pot	**NAA**	0.54C	9.92C	8.65C	1.31C	0.68	0.15
Foam	**IBA**	2.28A	41.10A	62.23A	5.77A	5.57	0.87
Foam	**NAA**	0.26C	3.47C	4.09C	0.47C	1.41	0.19
	IBA	1.98A**	34.14A**	51.35A**	4.61A**	4.71A**	0.79A**
	NAA	0.39B	6.69B	6.37B	0.89B	1.05B	0.17B

Root Number: *Auxin* LSD: 0.38, *Medium x Auxin* LSD: 0.54; Root Length: *Auxin* LSD: 7.02, *Medium x Auxin* LSD: 9.95; Root Fresh Weight: *Auxin* LSD: 10.89, *Medium x Auxin* LSD: 15.41; Root Dry Weight: *Auxin* LSD: 1.05, *Medium x Auxin* LSD: 1.48; Shoot Length: *Auxin* LSD: 1.11; Leaf Number: *Auxin* LSD: 0.17

Means followed by different letters are significantly different according to the LSD test.

*=P≤0.05; **=P≤0.01; ns= non-significant.

Root weights were significantly ($p \leq 0.01$) influenced by different auxins, and IBA injections have remarkably increased the weights of fresh and dry roots compared to NAA. IBA injections in two different media also gave the significant ($p \leq 0.05$ and $p \leq 0.01$) augmentations in root weight figures, as opposed to NAA injections (Table 2). Despite the non-significant interactions of *media x auxin x concentration* in terms of root weights of olive cuttings, IBA injections to foam plugs seem to be the most efficient to increase the figures of both variables.

Percent rooting, root number, and root length, together with root weights are the determinant parameters of root quality in cuttings. Results showed that IBA injections to both media gave very high figures compared to NAA injections. Former works showed that IBA is necessary for root formation in mature olive cuttings and much more effective than NAA to increase the number of rooted cuttings and the roots produced in this olive (İsfendiyaroğlu, 2016). The effects of NAA in olive cuttings were not entirely cleared out yet (Fabbri *et al.,* 2004). But sometimes, it is more efficient than IBA depending on cultivar, concentration, formulation and cutting collection time as well (Al Hattab *et al.,* 2018). In mature cuttings of 'Domat' olive, NAA was not efficient on rooting even at the high concentrations as much as IBA, but IBA-NAA mixes significantly increased the rooting variables compared to IBA treatment alone (İsfendiyaroğlu 2016). The low responsivity of olive cuttings to NAA injections may be related with the high transport velocity and/or non-oxidized, synthetic structure of this substance (Epstein and Ludwig-Müller, 1993). In fact, IBA gave the significantly higher number of roots compared to NAA in apple micro cuttings, subjected to continuous exposure (5 d) to a wide range of concentration (0-100µM) *in vitro* (De Klerk *et al.,* 1997).

Length of new shoots and new leaf numbers are the key factors on the growth of new propagules. Shoot length of olive cuttings were significantly influenced by different media ($p \leq 0.05$) and auxins ($p \leq 0.01$). Auxins also significantly ($p \leq 0.01$) affected the mean number of leaflets proliferated on rooted cuttings (Table 2). Interaction of *media x auxin x concentration* did not significantly influence the figures of both variables. Although the highest figures were obtained with IBA injections into the foam plugs, shoot lengths and leaf numbers seemed to be tended to decrease in parallel with the increasing injection concentrations. However, almost adverse concentration responsivities were observed in pot plugs (data not shown). These results probably derived from the quite different physical structures of both media.

As for the fresh callus volume, effects of different auxins significantly ($p \leq 0.01$) affected the figures. IBA gave rise to more than a two-fold increase in fresh callus volume compared to NAA. Significant interactions also found between *medium x concentration* ($p \leq 0.01$), *auxin x concentration* ($p \leq 0.05$) and *medium x auxin x concentration* ($p \leq 0.05$) as well. IBA injections into the pot and foam plugs gave inconsistent figures of fresh callus volumes, while NAA injections resulted in more pronounced decreases of figures particularly at higher concentrations, in foam plugs (Table 3). However, a positive correlation found between number of roots and fresh callus volume which was statistically significant at $\alpha=0.01$ level.

Origin of adventitious roots from basal callus tissue of cuttings has been generally associated with difficult-to-root species (Fabbri *et al.,* 2004), but this issue has not been investigated in olive cuttings so far. In fact, it was not predicted any relationship between root quality and callus formation in semi-hardwood cuttings of both easy and difficult-to-root olive varieties (Ayoub and Qrunfleh 2006; Mehri *et al.* 2013).

Delayed applications of auxins: Delayed auxin applications gave rise to non: significant interactions in terms of percent rooting of olive cuttings. Application of 5000 mg l^{-1}IBA at day 5, resulted in the highest percent rooting (83.3%). Later applications of IBA gave rise to marked decrease particularly at the 15th day, and the percent rooting figure was measured as 53.3%.

Table 3. Effects of different media, auxin and concentration on fresh callus volume (ml) of cuttings.

		InjectionConcentration (mg l^{-1})						Medium x Auxin
Medium	**Auxin**	**0**	**10**	**20**	**30**	**40**	**50**	
Pot	**IBA**	0.11b-f*	0.11b-f	0.14a-c	0.16a-c	0.15a-c	0.15a-c	0.14ns
Pot	**NAA**	0.01g	0.01g	0.03e-g	0.06d-g	0.08c-g	0.03e-g	0.04
Foam	**IBA**	0.15a-c	0.11b-e	0.04d-g	0.15a-c	0.15a-c	0.17ab	0.13
Foam	**NAA**	0.12b-d	0.22a	0.03fg	0.03e-g	0.01g	0.02g	0.07
IBA x Conc.		0.13ab*	0.11a-c	0.09b-d	0.16a	0.15a	0.16a	
NAA x Conc.		0.07c-e	0.12a-c	0.03e	0.05de	0.05de	0.03e	
Pot x Conc.		0.06cd**	0.06cd	0.09b-d	0.11a-c	0.12ab	0.09b-d	
Foam x Conc.		0.13ab	0.17a	0.04d	0.09bc	0.08b-d	0.10b-d	
Conc. Mean		0.10ns	0.11	0.06	0.10	0.10	0.09	
				Medium mean				
		Pot				**Foam**		
		0.09ns				0.10		
				Auxin mean				
		IBA				**NAA**		
		0.13A**				0.06B		

Auxin LSD:0.02, *Medium x Auxin x Conc.* LSD: 0.09, *Auxin x Conc.* LSD: 0.06, *Medium x Conc.* LSD: 0.06
Means followed by different letters are significantly different according to the LSD test.
*=P≤0.05; **=P≤0.01; ns= non-significant

Rooting of cuttings increased from 56.6 to 70% with the application of NAA at the 5th day, and remarkably decreased with the delays in applications (Table 4).

Table 4. Effects of different auxins and delayed applications on the rooting percentage (%) of cuttings.

	Day				
Auxin	**0**	**5**	**10**	**15**	**Auxin Mean**
IBA	70.00 w(44.43)ns	83.30 (56.44)	70.00 (44.43)	53.33 (32.23)	69.15 (44.38)ns
NAA	56.67 (34.52)	70.00 (44.43)	56.67 (34.52)	53.33 (32.23)	59.16 (36.42)
Day Mean	63.33ns (39.47)	76.65 (50.43)	63.33 (39.47)	53.33 (32.23)	

w:Transformed value; ns= non-significant

Different auxins significantly (p≤0.05) affected the root formation of cuttings, and IBA gave rise to higher mean number of roots compared to NAA (Table 5). Despite the non-significant interactions found between *auxin x day,* cuttings gave nearly the same responsivity to different application days, as observed in percent rootings. Effects of different auxins on root weights were found to be significant (p≤0.05), and IBA gave markedly higher figures of fresh/dry weights than NAA did (Table 5).

Table 5. Effects of different auxins on rooting parameters of cuttings.

Auxin	Root Number	Root Fresh Weight (mg)	Root Dry Weight (mg)
IBA	3.54 A*	63.50 A*	5.40 A*
NAA	2.12 B	33.39 B	3.32 B
	LSD: 1.24	LSD: 23.51	LSD: 1.94

Means followed by different letters are significantly different according to the LSD test.
*=P≤0.05; ns= non-significant

In this study, measured rooting variables were markedly high compared to the earlier works on 'Domat' olive cuttings. In fact, cuttings from the vigorous shoots on scaffold limbs of 'Domat' olive tree, 5 g l^{-1}IBA treatment at the 5th day of rooting process, significantly increased the percent rooting from 46.7 (day 0) to 63.3% together with the entire rooting variables assessed and applications at 10 and 15th days resulted in dramatical decreases in rooting figures (İsfendiyaroğlu, 2016). As a matter of fact, the first 5 days were probably coincided with the induction phase of rooting, when the endogenous auxin levels and ezyme activities showed significant fluctuations in the first 96h (4 days) in micro and macro cuttings of the difficult-to-root olives (Macedo *et al.,* 2013; Porfirio *et al.,* 2016b). In this work, a similar application time responsivity obtained with NAA applications as well. In fact, application at 5th day resulted in the increments of 23 and 29% in percent rooting respectively as compared to the day 0 (Table 4). These increments probably derived from the highest auxin sensitivity of cuttings at the 5th day, which probably coincided with auxin sensitive phase of rooting (De Klerk *et al*. 1999, Porfirio *et al*. 2016b). Differences observed in responsivity to application times of IBA and NAA in 'Domat' olive cuttings, probably derived from the different chemical structures together with the different action mechanism of these auxins (Epstein and Ludwig-Müller,1993), was thought.

Fresh callus volumes of olive cuttings did also show non-significant interactions in relation with different auxins that applied at the different days of rooting, as opposed to the results from different media injections (data not shown). Although, there was a statistically (α=0.01) positive correlation between root number and callus volume in media injections. From this point of view, practical treatments like wounding would be useful to increase basal callus formation and thereby to increase the root number of the cuttings of examined cultivar and probably the other important olives which have difficult-to-root cuttings as well (İsfendiyaroğlu and Özeker, 2012).

Despite the non-significant interactions in relation with different auxins applied at different days, mean shoot length and leaf number of cuttings markedly increased particularly with IBA application at 5th day (data not shown). This also proved that delayed auxin applications to olive cuttings were not only effective on root production but also efficient on the elongation of lateral shoots and leaflet formation. On the other hand, exogenously applied IBA was converted to IAA during rooting process in different plant cuttings including olive (Porfirio *et al*., 2016a). Transport of IAA to the growing points probably resulted with the shoot elongation and leaf formation in cuttings was thought.

In conclusion, IBA injections into the foam plugs gave the highest figures of percent rooting together with most rooting variables, that particularly predictive on root quality in cuttings of 'Domat' olive. The effects of NAA gave markedly lower figures in both media assessed. From this point of view, for supporting the exogenously applied auxin, media injections at the low concentrations of IBA (e.g. 50 mg l^{-1}) seems to be useful. Moreover, phenolic foam in proper densities should be considered as a medium option, because of its sterile structure, the ability of minimizing the transplanting losses and availability to automation, as much as coir based paper pots. Delayed auxin applications showed that IBA and NAA treatments 5 days after planting the cuttings resulted in the highest rooting figures of root quality parameters, butIBA was found to be more effective. This result is probably in relation with the conjugation and transport of IBA which is also a natural plant hormone (Epstein and Müller, 1993; De Klerk *et al*., 1999).

Despite the differences among IBA and NAA in terms of chemical structure and metabolism, auxin sensitivity of 'Domat' olive cuttings probably corresponded with the 3-7th days of in vivo rooting was concluded.

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